new technology

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# AWRE's Microcircuit Technology Group

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**AWRE's Microcircuit Technology Group was set up in 1966, by the then Ministry of Technology, to support microelectronics companies by supplying research and development information on materials and metallisation processes. From 1969 on, the Group worked largely on contract from industry, providing specialist equipment and expertise in thick-film technology, and this fact led, in 1971, to its being reorganised on an industrial consortium basis, half its finances then being derived by subscription from commercial companies and the other half being supplied by the Department of Trade and Industry. The Group has taken out several patents covering processes and materials in the thick-film field, and has granted licences to a number of commercial firms.**

**In this article the author reviews the work of the Group.**

Over the period 1967-1971 the Microcircuit Technology Group's primary source of funding was the then Ministry of Technology, though, from the outset, contractual work had been carried out with a number of companies and by 1970 was contributing some 15 per cent of the Group's income. Several companies were concerned in this aspect of the Group's activities (which covered both hardware and expertise, and included circuit-printing techniques, special-quality screens and circuit-forming pastes—all items that were not commercially available), and it was because of this increasing direct involvement with contract work, both with industry and with other Government laboratories, that a consortium was set up in 1971 (with six companies as members) to avoid the administrative complexities of individual contracting. A two year research and development programme was agreed by all the participants at the outset.

The work of the Group has been concerned with four main aspects of thick-film technology: the construction of complex circuits; improvements in conductor-paste properties; the construction of large circuit packages; and thermal-analysis and -design problems. When the work started the capability of the technology in this field was limited, both by the accuracy of the deposition process, and by the limitations imposed by the range of materials available and the variations in the properties of the printing pastes available. At the time the latter area—conductor and resistor pastes—was being studied actively by a number of manufacturers, but insulant materials, principally for use in multilayered circuits, were receiving little attention. Some work was therefore carried out at Aldermaston to develop such a material. The material developed was glass-based, was compatible with the majority of commercially available metallisation pastes, and had as a particular merit a very restricted flow on firing and refiring, enabling it to be used for constructing multilayer conductor arrays. In parallel with this development work, which was designed basically to achieve a great increase in the packing density obtainable in conductor networks, a project to improve the deposition process itself was carried out—high-density circuits are, after all, of value only if they can be reliably made in a reproducible way. Some two years were spent on these two areas, covering the techniques of multilayering—eg, the factors affecting the control of line widths and the printing of fine lines, and the production of equipment (particularly printing screens) to meet the specifications required. At the present time four types of screen are produced at AWRE: emulsion on mesh, impressed metal, chemically milled solid metal (double- and single-etched), and attached foil. These have been developed for different aspects of circuit printing: the emulsion type, for the greater part of circuit printing down to 75 micron dimensions; impressed metal, for long life; milled solid metal, for line printing below 75 micron; and attached foil, for thick printing, particularly for solder deposition. The factors influencing control of line widths, both for fine lines and in multilayers, have been investigated, and different types of dense array produced. Five-metallisation-layer circuits, with 200 20 $\times$ 50 micron windows and 1,000 crossovers covering 5 cm$^2$ with 100-micron feeder lines for integrated circuit attachment, were one of the early developments. More recently, 10 $\times$ 10 cm arrays with up to eight metallisation layers and with 10 metres of interconnect and 7,000 crossovers between layers have been constructed. The latter circuits were made using commercial pastes and the AWRE-developed glass, which is now produced commercially under licence.

The printing of fine lines has been studied by the Group primarily in relation to device attachment where small dimensions are essential. The relevant parameters have been investigated, and feeder patterns for integrated circuits of 30-micron lines on 100-micron centres have been produced at

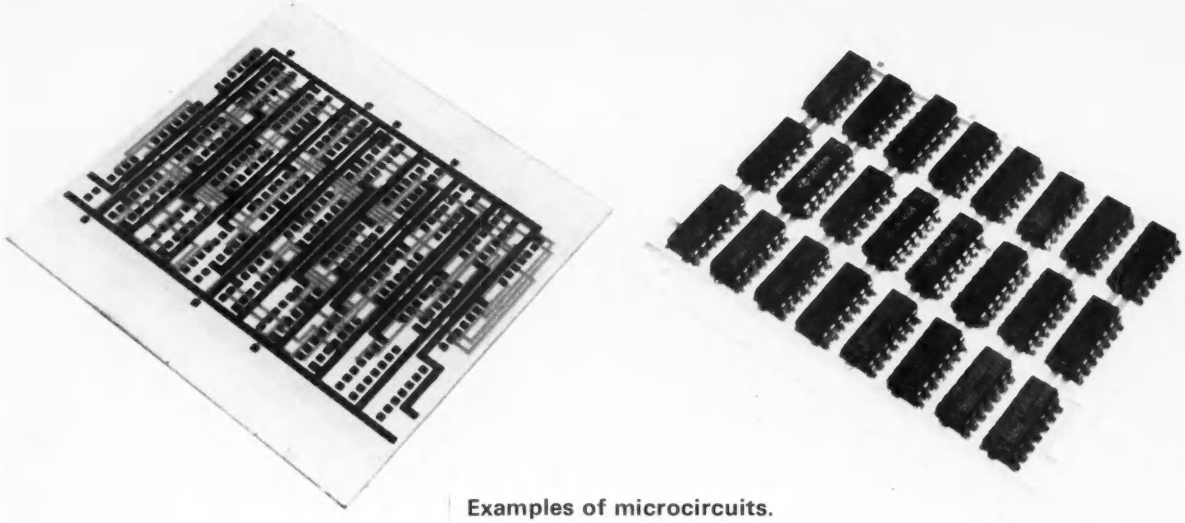
**Some relevant publications:**

Aspects of Multilayered Thick Film Hybrids; R. G. Loasby. *Solid State Technology*, May 1971.

Enhanced Property Thick Film Conductor Pastes; R. G. Loasby, H. Barlow and N. Davey. *Solid State Technology*, May 1972.

Thermal Design of Microcircuits; D. J. Dean and S. J. Reeves. *HM Stationery Office, AWRE Report No. 057/71.*

The Computation of Dynamic Equilibrium Temperature Distributions on Substrates Having a Temperature-Dependent Thermal Conductivity; D. J. Dean and S. J. Reeves. *InterNepcon 1971; HM Stationery Office, AWRE Report No. 059/71.*



**Examples of microcircuits.**

high yields and with a similar dimensional tolerance to wider lines (ie, ±10 micron). Quantitatively these points may be summarised as follows:

i Pattern dimensional control to ±20 micron over 15 cm. Layer superposition to this accuracy has been achieved through 10 layers.
ii Emulsion screens holding this tolerance over their life have been made in quantity.
iii Pattern-element dimensional control to ±10 micron. This covers most commercial metallisation and resistor pastes, and the AWRE multilayer insulant paste. The tolerance is independent of line width.
iv Line continuity, for runs of up to 10 metres per substrate, at 0.25 mm width.
v Feeder-line patterns, designed for device mounting, of 30-micron lines on 100-micron centres, at 20-micron thickness, deposited and solder coated.
vi Crossover densities of 1,000 in² and 7,000 crossovers per circuit at better than 99.99 per cent yield.

This capability was considered adequate to satisfy the circuit requirements envisaged for several years to come, and, hence, when this phase was completed two years ago, the activities of the Group changed direction back towards the materials sector, where some outstanding deficiencies, particularly in terms of bond strength and solder resistance, were becoming evident in commercial materials. For reasons originating principally in ease of processing, most thick-film conductor materials are noble-metal based, and these metals are unfortunately very reactive with common solder components, notably tin. As soldering is a much-favoured joining technique in microelectronics, failure through this noble-metal/solder reaction is quite common, and several conductor materials are now being developed to avoid such difficulties. These replacements are formulated from base metals (mainly copper and aluminium), and the pastes made from them are so constituted that the normal air-firing processing sequence may be used.

The first of these compositions—the copper-based—is usable outside the field of microelectronics, since its basic function is metal-to-ceramic joining: it has joint properties similar, but generally superior, to those of molybdenum-manganese joints, but processing is more straightforward, with an air-firing sequence at 960°C. The resultant metal requires no wet plating to make it solder-acceptant, and its joint strength is 30 per cent greater than the normal Mo-Mn range of values. With a silver top coat it will accept common solders and brazes, and it is free from the strength degradation common with the normal materials. Its principal applications are in metallising precision ceramic parts (where the lower firing temperature eliminates risk of part shrinkage), in normal ceramic-metal joining (which can be carried out in air), and in electronic circuitry.

A second series of enhanced property pastes under study by the Group is based on aluminium, which has a variety of merits for circuitry: it is a good conductor and solder-resistant, may be electro- and electrolessly-plated or overcoated with metals such as silver, and, above all, is of low cost. The Group's work has been directed towards formulating an aluminium-based printing paste compatible with the existing thick-film process—ie, which could be fired in air at temperatures below 1,000°C. The investigations have resulted in the development of a material which has high conductivity (between 15 and 25 milliohms per square), and is compatible with the normal process.

This area of special materials, which stems from component compatibility problems, is attracting increasing activity and effort, due to the greatly increasing complexity of circuits and the widening range of materials being used. Materials interaction is the main source of circuit failure, and is likely to remain so for some while. The situation at present is that deposition accuracy, and materials quality and range, are adequate for the large majority of industrial applications. Looking to the future, however, improvements in the primary aspects of precision and economics will entail developments in two main areas of circuit technology: in the printing of resistors, where the paste quality is now so high that the deposition accuracy is the limiting factor in their values, and in thermal-analysis and -design. Thermal design is having an increasingly important influence on circuit reliability, and the difficulties and costs associated with testing and re-design are becoming sufficiently significant for this factor to receive attention in addition to the more obvious aspect of thermal analysis. For example, from a knowledge of the physical properties of the materials in its structure and the thermal environment, it is possible to predict the temperatures arising on a substrate due to any distribution of circuit components. Sufficiently precise programs can be written to produce temperatures accurate to within a few degrees, and tables for use in this way have already been prepared. The designer is likely to become increasingly dependent on such tables in order to give higher guarantees of reliability—an important aspect as circuit densities increase.

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# Computer Graphics in Planning

**R. Baxter, Centre for Land Use and Built Form Studies, University of Cambridge**

In the last issue of New Technology we published an article reviewing the Experimental Cartography Unit's work on the development of automated systems of mapmaking. The Unit's work has already demonstrated the practicability of digitising an existing map, processing the digitised data on a computer, and then deriving from the data another map incorporating the features required. In general, the final map, which can be drawn either on a flat-bed plotter or on a cathode-ray tube, consists of an amalgamation of existing maps plotted at a reduced scale, and the emphasis is, of course, on accuracy. There are times, however, when accuracy is of secondary importance to speed: in other words, when a 'symbolic' map will prove satisfactory, provided that it is available quickly.

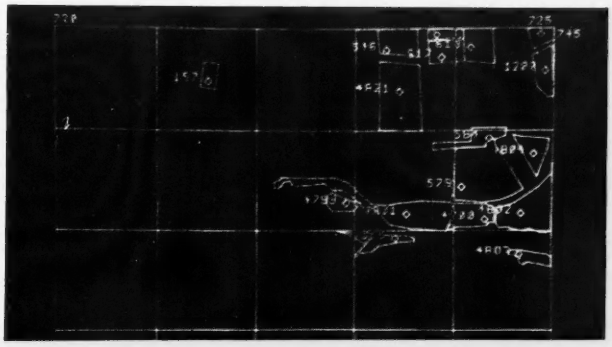
In this note, the author outlines the role computer graphics can play in this context, and presents two examples derived from DTI's Computer-Aided Design Centre.

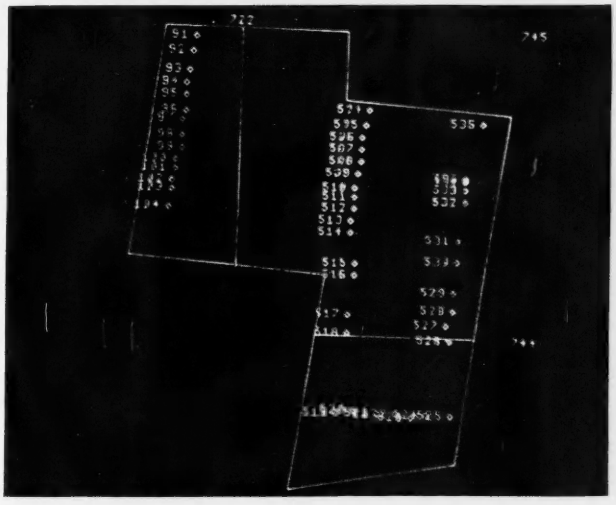
Computer graphics mean different things to different people. In part this reflects the state of technology to which they are exposed, but it also characterises their own understanding of the scope of computers in their own discipline. To some, the use of a lineprinter to produce histograms rather than numeric tabulations would constitute graphics; to others, the interface with the digital plotter would be the limit of their definition. The common realisation, however, is that digital information frequently has attributes which can best be displayed other than by lineprinter listings. What is frequently lacking is an awareness of what computer hardware and software exist to present this information in a more coherent manner without manual intervention.

The use of the computer in automated cartography is one application in this field. Work at the Royal College of Art and the Ordnance Survey has proved the feasibility of holding digitised data about a geographical region on magnetic tape, and using the data to draw maps of specified information, location and scale on a flatbed plotter. The emphasis in this work has been on the accuracy of the finished article, and to a certain degree technology has been advanced to meet these needs. There are times, however, when a far more symbolic map is called for—one which does not require the same level of cartographic accuracy but puts speed as the prime constraint. An example would be the ability to extract spatial information from a data base and draw it on a visual unit whilst on-line to a computer.

By way of introducing this type of application, it is helpful to consider the use of the computer by practising planners. Planners increasingly employ computers for data collection and storage, for analysis and modelling, and for plan and decision making. The existence of a planning-information system becomes almost obligatory under the 1968 Act, especially if the above tasks are performed within a computer environment. Once in existence, the computerised information system opens up a vast new range of useful application areas. Summary tables of the information contents can, of course, be produced in the customary manner, but the very spatial component of planning information makes it ideally suited to graphic mapping on some form of visual display unit.

The two illustrations in the next column exemplify the potentialities of computer graphics in this field. The examples form part of a comprehensive information-retrieval and -display system operational at the Computer-Aided Design Centre in Cambridge. In this case, a tektronix storage tube is connected on-line to a multi-access real-time central computer, so that the user is effectively in direct communication with the planning information system. He can interrogate this information base and produce the usual summary tables, and, at the same time, he can request information to be displayed spatially on the storage tube. In one example the planner has requested a display of all the non-residential land-use parcels in a specified area of the town. The relevant information in the data base is





searched and the map drawn on the display, as shown in the first figure. In the other example the planner requires a quick appraisal of the residential properties within a polygonally defined area of the town. Once again the appropriate file is searched, the necessary information extracted and the map drawn and displayed, as in the second figure.

These two examples merely illustrate the type of retrieval and display techniques which are available. The techniques become relevant when requests for information put speed of response at a high priority, and when the spatial contents become significant. The computer graphics produced are more suited to interpretation than the usual numeric outputs, and it is argued that this application area will assume increasing importance in planning once the necessary knowhow and expertise are diffused. The problem at this stage is to match the supply of systems against the ill-defined demands of planners.

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# In Ever-Decreasing Circles . . . NPL and VIC 62 improve ship manoeuvrability

## Manoeuvring out of danger

VERY large tankers need 15 minutes and several miles to come to rest from their cruising speed, and obviously any development reducing this time and distance would contribute greatly to safety at sea. Fitting such monsters with brakes, however, is easier said than done, though some years ago the National Physical Laboratory's Ship Division, in co-operation with the British Shipbuilding Research Association, did explore the feasibility of doing so. Using models of ships, various auxiliary stopping systems were evaluated, including water parachutes, hinged underwater flaps and a water-duct system built into the ship's bow. All the devices worked, but unfortunately not to the extent required (the braking effect being relatively modest), and, so far as is known, no shipowner has judged the gain in safety to be worth the disadvantages in weight, cost and complication of installing equipment of the type tested.

Looking at the problem again, NPL's Ship Division decided that it would be more worthwhile to approach it from the point of view of steering rather than that of simple deceleration. As any seaman familiar with the loss of speed which occurs during a turn will confirm, steering can in fact be used to get way off a ship. The snag is that steering demands the use of the rudder, and in a single-screw ship the rudder is ineffective while the propeller is running astern. Hence one can either use the propeller with stern revolutions to slow the ship down, or one can use the rudder to slow the ship down; what one can't do is to use both at once. NPL concentrated therefore on improving the effectiveness of the rudder, with the aim of so tightening the turning circle as to give a hazarded ship the chance of turning away from danger in time, and, in so doing, slowing itself down.

## The rotating-cylinder rudder

A conventional rudder has a limiting helm angle of about 35°: beyond this angle a stalling effect begins to make itself felt, and the increase in rudder force achieved by widening the angle is not usually considered sufficient to justify the more complicated steering gear required to achieve the wider angles. The stalling effect is due to flow separation behind the rudder (see Figure 1), which prevents the propeller race from being directed along the angle of the rudder. NPL's tests with model ships demonstrated that the rudder angle can in fact be increased with good results to as wide as 60°: the drag at this angle is large, and this, together with the small increase achieved in lift, gives a tighter turning circle and a greater speed loss. More significant, however, was Ship Division's finding that incorporation into the rudder of some method of boundary-layer control produced benefits out of all proportion to the simplicity of the approach. One method of achieving this control—replacing the rudder's leading edge by a rotating cylinder—was borrowed from the aeronautical field. Tests with model ships steered by a rudder embodying such a cylinder were a complete success, showing that unstalled flow can be maintained at helm angles as wide

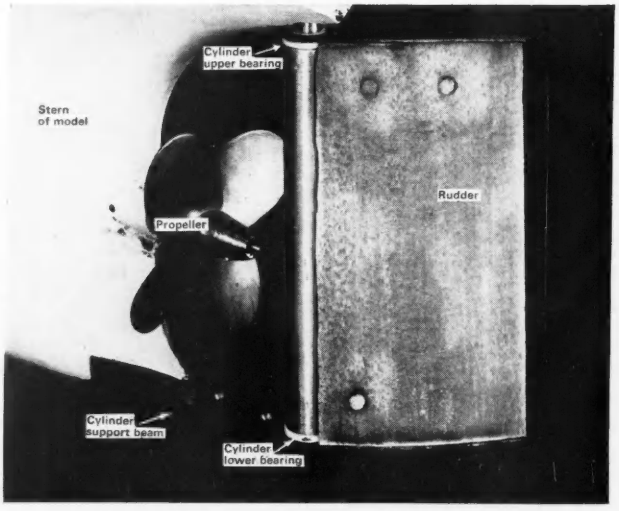
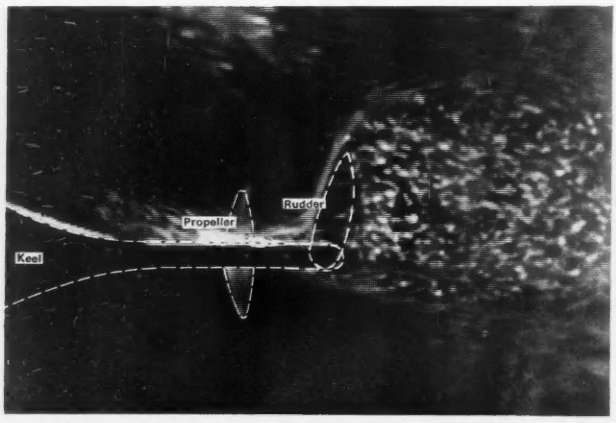
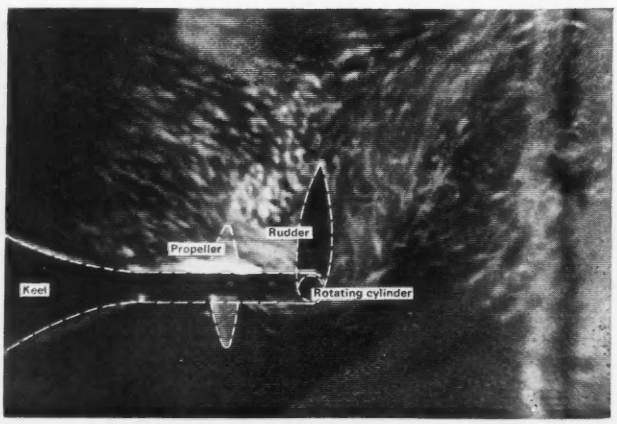



*Figure 2.* Above: *General arrangement of NPL's rotating-cylinder rudder, which is not subject to the deleterious flow separation which usually occurs on conventional rudders at angles wider than 35°.*

Below: *How effectively the rotating cylinder prevents flow separation is shown in this photograph, taken during flow tests on a 250,000-tonne tanker model with its rudder at an angle of 90°. Since the propeller race can be diverted through such large angles with no risk of stalling, a ship fitted with a rotating-cylinder rudder is able to turn much more tightly, and at higher rates of turn at all speeds, than one fitted with a rudder of conventional type.*

*Figure 1. Flow over the rudder of a model of a 250,000-tonne tanker with the rudder set at an angle of 80°. When the rudder is of conventional type, as here, the very wide angle results in flow separation, which diminishes the rudder's 'bite' on the water. In the illustration below, the flow is from left to right, and the separation is clearly visible behind the rudder.*



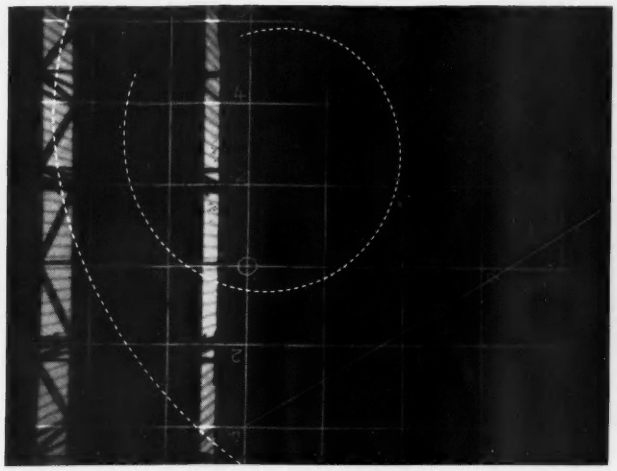


*Figure 3. The dotted tracks trace the turning circles of a radio-controlled ship model in the manoeuvring basin of NPL's Ship Division. The two tracks, which were recorded by taking multi-exposure photographs of a light source on board the model, have here been superimposed to illustrate the much tighter turning circle available from the rotating-cylinder (vis-a-vis a conventional-type) rudder.*

*Figure 4. VIC 62—the elderly 200-tonne coaster recently commissioned by NPL as a sea-trials vehicle. Here, with her original barn-door rudder replaced by one embodying a rotating-cylinder, she shows how readily she can turn about her axis—virtually like a puppy chasing its tail.*

as 90°. How the cylinder prevents flow separation can be seen from Figure 2. The effects on manoeuvrability (Figure 3) were dramatic. Fitted with a rotating-cylinder rudder, a radio-controlled model had a turning circle of virtually zero diameter, the vessel pivoting round a vertical axis passing through the hull just forward of midships; and, because the rudder's drag cancelled out the ahead thrust of the propeller, the model was able to manoeuvre indefinitely in this way at full-ahead revolutions without making headway.

A second type of circulation-control rudder under investigation by NPL is based on the use of jet flaps—another principle imported from aeronautical practice. The jet flaps (a sheet of water ejected from slots at the trailing edge of the rudder) increase maximum lift, and can also be used to maintain course at the small helm angles required on the open ocean, so allowing the main steering gear to be closed down.

## Manoeuvring in shallow water

The spectacular increase in the size of ships over the last 10 years has brought with it other manoeuvrability problems in addition to that of bringing them to a halt. Such vessels now find themselves in shallow water for a considerable portion of their operating time, and shallow water has long been known to affect squat and steerability. The information available, however, is sparse and confined to conventional hull forms. Consequently, in 1970, NPL's Ship Division started a series of investigations into the behaviour of modern tanker hulls in shallow water. Its model tests have already demonstrated that fully laden tankers settle down further in shoal water than in deep, and also trim by the bow. In shallows a ship's forefoot can sink more than a metre further into the water, and this so called *squat* could well cause grounding if not catered for.

The effects of shallows on steering can be equally marked. For example, with an underkeel clearance of 2 metres the turning circle is more than double that in deep water. And a curious feature of shallow-water turning is that the rate of change of heading is not reduced in anything like the same ratio as the curvature of the path followed; hence loss of speed due to turning is less in shallow water than in deep.

## Sea trials with VIC 62

In ship research all model and theoretical work has ultimately to be validated by full-scale observations—which means working at sea. NPL has always found shipping companies very helpful in providing test facilities aboard working ships, but owners are understandably reluctant to lend ships for trials lasting for days or weeks on end, and, even more understandably, they tend to take a jaundiced view of shallow-water manoeuvring experiments involving risk of going aground. NPL hence decided that the only reliable way of obtaining a constantly available floating test bed was to buy their own ship. VIC 62, the Laboratory's first venture into the ship-owning business, is shown in Figure 4. VIC 62 was built 30 years ago as a steam 'puffer', and like all Scottish puffers lies aground quite happily on a sandy bottom. For much of her life she served the Navy as an ammunition carrier, and she has not altered much in appearance since she was bought at scrap value from the Navy. Inboard, however, both the original massive boiler and the compound steam engine have been removed (the steam engine now reposes in the Science Museum), and the engine room has been re-equipped with a large 440-v ac electric generator and a new diesel main engine capable of driving the elderly hull at speeds never contemplated when she was first built. In the hold a 6-m cargo-type container—virtually a mobile laboratory, which can be lifted from one ship to another, or taken ashore bodily for maintenance or re-equipping—houses the sophisticated electronic recording equipment required for sea trials.

Priority in the sea-going experiments is being given to ship handling and manoeuvring in deep and shallow water, and the first trials are being devoted to rudder behaviour. VIC 62's original barn-door rudder has been replaced by one embodying a rotating cylinder, designed and built by NPL. Hence the unusual behaviour of this elderly 200-tonne coaster in the Solent recently, when she could be seen periodically interrupting her staid progress across Stokes Bay to spin sharply about her vertical axis. As the accompanying illustrations show, the trials fully confirmed the encouraging results of the ship-model tests. With boundary-layer control the rudder was effective at angles as wide as 90°, and consequently VIC 62 was able to turn continuously about her axis at a rate substantially higher than could be obtained with an ordinary rudder set at zero ahead speed and the propeller turning at full-ahead revolutions.

The rudder trials will be followed by investigations of squat and steering behaviour in shallow water.

**More information:** Mr. B. N. Steele, NPL, Ship Division, Faggs Road, Feltham, Middlesex. Tel: 01-977 3222, ext 5011.

# ECE Appreciation Course and Study Tour on the Uses of Plywood and Blockboard

At the invitation of Her Majesty's Government, a United Nations Economic Commission for Europe Timber Committee Appreciation Course and Study Tour took place in the United Kingdom from 11 to 20 September, 1972, under the direction of the Department of Trade and Industry. The event, which was highly successful, attracted some 50 representatives from 16 countries, including the United States, USSR, Malaya and Scandinavia, and was attended by commercial participants at Board level as well as a number of research, engineering, architectural and United Nations officials.

This was one of a continuing series of courses, study tours and symposia in the scheduled work of the United Nations Economic Commission for Europe Timber Committee. Previous events this year, some of which were held in conjunction with other UN Agencies, have included symposia in Switzerland, Finland and Hungary and a study tour in Germany, but this is the first time that the Committee has held an event of this nature in the United Kingdom. The United Kingdom was asked to act as host country, since it is the world's second largest importer of plywood (after the USA), importing around 1 million $m^3$ of plywood a year, which represents well over 90 per cent of UK consumption.

The academic content of the Course, which was held from September 11 to 15 at the Imperial College of Science and Technology, Kensington, London, was organised by the Director of Studies appointed by the Department, Dr L. G. Booth. Some 20 lectures were given by internationally-known specialists in the field, and simultaneously interpreted into French and Russian by United Nations interpreters. Discussion periods followed each lecture, and to illustrate the subjects of the lectures afternoon visits were made to companies and establishments at Farnborough (Hants), Twickenham, High Wycombe, Dagenham and Leyton. Some 45 people took part in the subsequent Study Tour from 17 to 20 September, when visits were paid to various additional companies and establishments in other parts of the United Kingdom, including York, Nottingham, Northampton, Milton Keynes, Bletchley, Chipping Warden and Princes Risborough, where the practical applications of plywood and blockboard were examined by the participants.

Despite the crowded programme and tight timetable, a number of social functions were arranged, including a reception by Her Majesty's Government at the Savoy Hotel, at which the Earl and Countess of Limerick were hosts, and one by the Director of the Timber Trades Journal at the Stationers Hall in the City of London, which was attended by Mr. A. Grant, Parliamentary Under Secretary of State for Industrial Development (see picture) and many of the leading personalities of the timber industry.

Full details of the Course will be found in the September 20 and 27 and October 4 issues of *Timber and Plywood* and the September 16, 23 and 30 issues of *The Timber Trades Journal*. The latter journal also produced a special full-length supplement on October 7, devoted entirely to the event. A report on the Appreciation Course and Study Tour is to be presented for consideration at the United Nations Economic Commission for Europe Timber Committee's annual session, which is to take place at the Palais des Nations, Geneva, from October 30 to November 3, 1972, and which will be attended by representatives from some 24 countries, as well as UN bodies and specialised agencies and non-governmental organisations.

The Paper, Printing, Publishing, Services and Distribution Division (PSD) of the Department of Trade and Industry, which sponsors the imported timber trade, was responsible for the organisation and administration throughout.

*Mr. A. Grant, Parliamentary Under Secretary of State for Industrial Development, addressing the gathering at a reception given by the Directors of the* Timber Trades Journal *on the occasion of the ECE Appreciation Course and Study Tour on the Uses of Plywood and Blockboard. On his left is Mr. T. J. Peck, Secretary of the UN ECE Timber Committee, Geneva, and, on his right, Mr. R. Woolley, Editor-in-Chief of the Benn Group.*

*Members of the ECE Appreciation Course on Plywood and Blockboard examining the quality of finishes on plywood.*

# Six DTI Requirements Boards to implement customer/contractor relationship in R & D

*The Minister for Aerospace, DTI's Chief Scientist, and the Chairmen of five of the six Requirements Boards which are being set up to implement the customer/contractor principle in industrial R & D sponsored by DTI. Left to right: Mr. John Crane (Engineering Materials Board), Mr. John Atwell (Mechanical Engineering and Machine Tools Board), Mr. Nigel Broackes (Ship and Marine Technology Board), Mr. Michael Heseltine (Minister for Aerospace), Dr. Ieuan Maddock (Chief Scientist), Mr. John Nichols (Computers, Systems and Electronics Board), Mr. Donald Clark (Chemical and Mineral Processes and Plant Board).*

IN its White Paper, *Framework for Government Research and Development* (*Cmnd.* 5046, July 1972), the Government reaffirmed its intention to implement the customer/contractor principle which Lord Rothschild had recommended for control of Government R & D in the Green Paper of the same title (*Cmnd.* 4814, November 1971). The White Paper pointed out that '. . . departmental customers must work in partnership with their research and development "contractors", whether inside or outside the Department. Responsibilities are then clear. Departments, as customers, define their requirements; contractors advise on the feasibility of meeting them and undertake the work; and the arrangements between them must be such as to ensure that the objectives remain attainable within reasonable cost. This is the customer/contractor approach.' To implement this approach the Department of Trade and Industry is setting up six Requirements Boards, each concerned with customer interests in a specific technological field, which will determine, in agreement with the Minister for Aerospace, and within the funds available, the objectives and balance of the Department's intramural and (where appropriate) extra-mural R & D programme in the relevant field. Initially each Board will be responsible for research expenditure of about £2 million. R & D programmes funded by DTI are undertaken either to support Government's own functions or to support industry, and they cover a wide area of technology outside the special spheres of aerospace and nuclear energy. The contractors for this R & D include the DTI's own industrial research establishments (National Physical Laboratory, Teddington; National Engineering Laboratory, East Kilbride; Warren Spring Laboratory, Stevenage; Safety in Mines Research Establishment, Sheffield and Buxton; and Laboratory of the Government Chemist, London), the UK Atomic Energy Authority (non-nuclear applications), the grant-aided Research Associations, industrial companies, independent consultant laboratories, universities and Research Councils.

Broad policy guidance for the Requirements Boards will be provided through a committee of chairmen under the Minister for Aerospace. Each Board will report annually to the Minister, and the reports will be published. Boards will generally consist of 12 members, and will include six independent members from industry, two independent scientists, and appropriate official representatives of DTI's main customer divisions, other Government departments, the main contractors and DTI's research divisions. Other customer divisions and contractors may expect to be consulted by the appropriate Board when matters relating to their particular interests are being considered, and each Board will be able to obtain specialist advice from independent and Government experts. A new Research Requirements Division, under the Department's Chief Scientist, will provide technical, management and financial back-up services for the Boards.

On October 16 Mr. Michael Heseltine, Minister for Aerospace, announced the names of the Chairmen who are to head five of the six Boards. They are:

| Chairman | Requirements Board |
|---|---|
| Mr. Nigel Broackes, Chairman, Trafalgar House Investments Ltd. | Ship and Marine Technology |
| Mr. John Atwell, Director, Weir Group Ltd. | Mechanical Engineering and Machine Tools |
| Mr. John Crane, Director, Imperial Metal Industries Ltd. | Engineering Materials |
| Mr. John Nichols, Under Secretary, DTI | Computers, Systems and Electronics |
| Mr. Donald Clark, Under Secretary, DTI | Chemical and Mineral Processes and Plant |

The Chairman of the sixth Board—that covering Standards and Metrology—will be announced later.

# news

## Swansea Tribology Centre

The Council of the University College of Swansea has approved the continuation of the Swansea Tribology Centre as a purely College activity now that the initial period of Government support has ended. The Centre was set up, with the former Ministry of Technology's support, to supply a service of sponsored research, design and consultancy in all aspects of tribology, and to provide a new link between industry and specialists on the College staff. It has achieved its target of commercial viability within the planned four-year period, and the indications are that the demand for its consultancy services is growing rapidly. The scope of its work has broadened to include the analysis of plant failures, re-design of faulty plant, surveys of plant lubrication, and general maintenance engineering and systems.

Over 180 contracts totalling £90,000 have been received—almost half (to a value of over £40,000) in the financial year 1971-72. Clients have included many of the largest private companies and public corporations, and retainers are now received from some of the largest organisations.

More information: The Director, Swansea Tribology Centre, University College of Swansea, Singleton Park, Swansea SA2 8PP. Tel: Swansea 24561.

## NCT course on dry bearings

A one-day course on *Dry Bearings Design and Material Selection*, sponsored by the National Centre of Tribology and the North Western Section of the Institution of Mechanical Engineers, will be held at the National Centre of Tribology, Risley, on November 16, 1972. The aim is to present practical information on the design of, and materials available for, bearings which do not use conventional lubrication; ie, the course is oriented towards practising engineers. Lectures will be given on: basic mechanisms of friction and wear; materials available; the properties of polymers used for bearings; and dry lubricants. Course fee, including luncheon refreshments, is £12. More information: Mr. A. J. Walton, National Centre of Tribology, UKAEA, Risley, Near Warrington, Lancashire. Tel: 0925 31244, ext. 3564.

## New English-language index to VDI Richtlinien

A new and up-to-date edition of the English-language *Index to VDI Richtlinien* can now be obtained from DTI. Produced by the Department in collaboration with the British Standards Institution, the Index lists all the engineering guidelines published by the Verein Deutscher Ingenieure (Association of German Engineers) as VDI Richtlinien—the authoritative data sheets covering good practice in many different branches of engineering and technology, and frequently specified for use in export tenders, both for Germany and other countries. Their nearest United Kingdom equivalents are the BSI Codes of Practice, but Richtlinien, written in the form of recommendations, are rather more detailed and wider in scope. The 1972 Index includes two new sections, one on process technology and the other on reliability. Among the other Richtlinien referred to are those dealing with noise abatement and vibration control (27 items), air-pollution control (89 items), engineering techniques and design, metrology, dust control, plastics, heating and ventilation and various aspects of materials handling (163 items).

DTI's Overseas Technical Information Unit holds a complete and up-to-date collection of VDI Richtlinien in German, and operates an information and loan service for United Kingdom industry; and the English-language Index provides designers and engineers with a guide to this collection. (The Department is also collaborating with the publishers Peter Peregrinus Ltd., who are issuing a series of the Richtlinien in English.) Copies of the 1972 *Index to VDI Richtlinien* are available (£0.50, post paid) from either Overseas Technical Information Unit, Department of Trade and Industry, Room 201, Abell House, John Islip Street, London SW1P 4LN or DTI Technology Reports Centre, Station Square House, St. Mary Cray, Orpington, Kent BR5 3RF.

## Letter to the Editor

Dear Sir,

In his letter published in New Technology No. 62, Mr. A. F. Sherwood appears to suggest that my article entitled *Surface Coatings for Use under Radioactive Contamination or Exposure* contains an implied criticism of the B.S. 4247 test. This was certainly not intended, as I am aware of the detailed thought and effort which went into its conception; indeed members of the Authority staff collaborated in the drafting of the specification.

I feel that all my paper indicates is that different test methods may give very different results, and this perhaps needs stressing to potential users.

Yours faithfully,
P. Walker.

UKAEA,
Atomic Weapons Research Establishment,
Building SB24,
Aldermaston,
Reading RG7 4PR.

## Blacknest Centre Production Control Group

As part of its involvement in systems for computers, the Computers Systems and Electronics Division of the Department of Trade and Industry has an interest in computer-aided production control. In particular, it is interested in persuading industry to adopt, where appropriate, advanced methods for the aid of management. One means of persuasion is to show to senior managers working systems which have proved useful in real industrial environments. To this end, the Production Control Group at the Blacknest Centre of the United Kingdom Atomic Energy Authority (AWRE) has been asked to undertake, as a new project, the setting up of a small number of Industrial Demonstration Centres.

In the context of this project, 'industry' means small to medium firms (those employing a maximum of about 500 people) which are engaged upon mechanical engineering manufacture in the small batch and jobbing environment. The term 'production control' can extend through any or all facets of the management of production, with probable emphasis on workload scheduling, job costing and stock control. The firms selected as demonstration centres will be those capable of showing computer systems in active use, and capable of demonstrating their effectiveness in production control. The particular software and hardware used will be of secondary importance, although the demonstration centres will cover as wide a range of systems as possible within the context of the project. Once established, the demonstration centres will receive visitors at convenient times, and, if possible, organise lectures on the firm's premises as well as discussing the advantages and problems they have experienced in using modern systems of production control.

The first Industrial Demonstration Centre will, it is hoped, be in operation in early 1973. More information: The Secretary, Blacknest Centre, UKAEA, Brimpton, Reading RG7 4RS. Tel: Tadley 4111, ext 5951.

## VAT—more Computerguides available

Early in 1972, the National Computing Centre published Book 1 of *Computerguide 6: Value-Added Tax*. Books 2 and 3 of the series have now appeared:

Book 2 (price £1.50) contains information available since the April Budget (Book 1 was written before the Budget), together with some of the findings arising from discussions of the VAT Working Groups—dialogues between NCC Members and officers of HM Customs and Excise Computer Research Unit. The book concentrates on those facets of VAT legislation which affect data-processing systems (eg, the records that will have to be maintained, the source of the data, the production of tax invoices, the calculations of the Retail Schemes) and points of liability on which DP systems will need definition. Flow charts show logically the points of invoice classification and the various data totals required.

Book 3 (price £1.00) contains the report of the eight NCC VAT Working Groups which investigated with HM Customs and Excise the particular problems of implementing VAT accounting on computer-based systems. The aim of this report is to bring together from all the meetings recommendations made to HM Customs and Excise; recommendations to other computer users; recommendations for further action by NCC; and anticipated resources and costs.

More information: Head of Public Relations, The National Computing Centre Ltd., Quay House, Quay Street, Manchester M3 3HU. Tel: 061-832 9731.

**More information**: Where possible, items in *New Technology* indicate the best sources of further information. Readers are advised also to seek information on matters relating to *New Technology* from the following DTI regional offices: Edinburgh, 031-225 1822; Cardiff 62131; Newcastle upon Tyne 27575; Manchester, 061-832 9111; Leeds 38232; Nottingham 46121; Birmingham, 021-643 8221; Bristol 21071; London and South East, 01-684 9781; Eastern, 01-828 4355. In Northern Ireland, information is given by the Dept. of Industrial and Forensic Science, Belfast 21722.

**Editorial Office**: Department of Trade and Industry, Room 439, 1 Victoria Street, London SW1H 0ET. Tel: 01-222 7877, ext. 2620.

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